THIS IS ONE VOLUME OF A SIX VOLUME SET WHICH INCLUDES:

VOLUME I: FIELD OPERATIONS (FO)
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VOLUME III: GEOTECHNICAL (GT)
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	Effective Date:	March 1, 1992
Category 2	Organization:	Environmental Management

TITLE:
WELL DEVELOPMENT

Approved By: _____ MAY 1/2 '92
(Name of Approver) (Date)

1.0 TABLE OF CONTENTS

2.0 PURPOSE AND SCOPE

This standard operating procedure (SOP) describes procedures that will be used at the Rocky Flats Plant (RFP) to develop new and redevelop pre-existing monitoring wells.

3.0 RESPONSIBILITIES AND QUALIFICATIONS

All personnel performing this procedure are required to have 40-hour OSHA classroom training which meets Department of Labor regulation 29 CFR 1910.120(e)(3)(i). In addition, all personnel are required to have a complete understanding of the procedures described within this SOP and have received specific training regarding these procedures.

4.0 REFERENCES

4.1 SOURCE REFERENCES

The following is a list of references reviewed prior to the writing of this procedure:

A Compendium of Superfund Field Operations Methods. EPA/540/P-87/001. December 1987.

Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA. Interim Final. October 1988.

RCRA Facility Investigation Guidance. Interim Final. May 1989.

RCRA Groundwater Monitoring Technical Enforcement Guidance Document. EPA. OSWER-9950.1. September 1986.

4.2 INTERNAL REFERENCES

Related SOPs cross-referenced by this SOP are as follows:

- SOP GT.6, Monitoring Well and Piezometer Installation
- SOP FO.3, General Equipment Decontamination
- SOP FO.5, Handling of Purge and Development Water
- SOP FO.15, Use of PIDs and FIDs
- SOP FO.16, Field Radiological Measurements
- SOP GW.1, Water Level Measurements in Walls and Piezometers

5.0 PROCEDURES FOR MONITORING WELL DEVELOPMENT AND REDEVELOPMENT

Monitoring well development is the process by which the well drilling fluids and mobile particulates are removed from within and adjacent to the newly installed wells. This process can also be used to remove sediment or other built-up material from an older well. The objective of a completed well development activity is to provide groundwater inflow that is as physically and chemically representative as possible of the aquifer that is open to the piezometer or well.

5.1 MATERIALS AND EQUIPMENT

The following is a list of well development and associated equipment:

- Stainless steel or Teflon® bailer
- Mechanical reel equipped with a stainless steel cable
- Inertial pump
- Water quality test kit (pH, SC, T, and turbidity)
- Wash/Rinse tubs

- Clear plastic sheeting or vinyl sheeting which may be decontaminated.
- Disposable latex or vinyl gloves
- Nonphosphate, lab detergent (e.g., Liquinox)
- Containers for development water (see SOP FO.5, Handling of Purge and Development Water)
- Water level probe - sufficiently accurate to measure water levels to the nearest 0.01 foot
- Weighted tape measure - sufficiently accurate to measure depths to the nearest 0.10 foot
- Distilled water
- Field book and field forms
- Health and safety equipment
- Organic vapor detector (OVD)
- Calculator

5.2 PROCEDURES

5.2.1 Well Development Procedures for New Wells

Perform the development as soon as practical after well installation, but no sooner than 48 hours after grouting and pad installation is completed. These new wells will be developed utilizing low-energy methods. The equipment of choice for well development is an inertial pump or bottom discharge/filling bailer. High-energy methods such as submersible pumps, surge blocks, overpumping, backwashing and well jetting will not be used due to the possibility of formation fines clogging the well screen.

All newly installed wells will be checked for the presence of immiscible layers prior to well development. The method for detecting these layers in monitoring wells is discussed in SOP GW.1,

Water Level Measurements in Wells and Piezometers. If an immiscible layer of 5 mm or greater has been detected in a newly installed well, well development procedures will not continue until the EG&G project manager has been notified. In the case where an immiscible layer is not identified, a water level measurement will be taken according to SOP GW.1, Water Level Measurements, and well development activities will continue. The water level measurement along with the total depth measurement will be used to determine the volume of water in the well casing. Well casing calculations are presented in Subsection 5.2.1.1 of this SOP.

Formation water and fines will be evacuated by slowly lowering and raising the inertial pump or bailer intake throughout the water column. The inertial pump may be placed inside a decontaminated 1-inch diameter PVC pipe if the pump intake cannot be lowered to the bottom of the well. The PVC pipe will prevent the inertial pump intake from bending prior to reaching the desired depth. EG&G will determine whether an inertial pump will be dedicated to a specific well based on verified organic vapor detector (OVD) readings obtained during the drilling of the well. OVD readings are described in SOP FO.15, Photoionization Detectors (PIDs) and Flame Ionizing Detectors (FIDs). If a bailer is used for well development, it will be used with a mechanical reel equipped with a stainless steel cable. Development equipment will be protected from the ground surface with clear plastic sheeting. Development equipment, including bailers and pumps, will be decontaminated before well development begins and between well sites according to SOP FO.3, General Equipment Decontamination.

Estimated recharge rates will be measured following the procedures outlined in SOP GW.1, Water Level Measurements in Well and Piezometers. Decontamination and development water will be handled according to SOP FO.7., Handling of Decontamination Water and Wash Water, and SOP FO.5, Handling of Purge and Development Water, respectively.

5.2.1.1 Development Criteria for New Wells

Development shall proceed in the manner described herein and continue until the following are met:

- Removal of a minimum of five well casing volumes. Typical well casing volume calculations include:

  a. 2-inch diameter well:
  0.16 gal/ft x ___(linear ft of water) = gallons of water

  b. 4-inch diameter well:
  0.65 gal/ft x ___ (linear ft of water) = gallons of water

  c. 6-inch diameter well:
  1.5 gal/ft x ___ (linear ft of water) = gallons of water

  Graduated containers will be used to measure the amount of water removed.

1. If the initial water measurment (WLM) indicates water is at an elevation below the screened interval, the well is considered "technically dry" for development purposes. Most 1991-1992 wells are constructed with a sump that is approximately 2 feet deep. If a well is dry or technically dry, it is recommended monthly water level measurements be taken for one year to check seasonal changes in the water table. If a well remains consistently dry for one year, it will be subject to quarterly WLMs and listed as undeveloped. A well will be developed within two weeks

following a WLM which indicates the well is not dry (water covering all or a portion of the screened interval).

2. When a well dewaters during development, deionized (DI) water may be added to the well. Prior to the addition of DI water, a recharge rate will be established using a 10-minute recharge period and extrapolated to a 30-minute recharge period. If the recharge rate will allow for evacuating the total volume needed to complete five volumes within 4 to 6 hours, no DI water will be added. If this condition does not exist, the following procedure is recommended. The volume(s) of DI water to be added, herein known as screened interval volume(s), is calculated using the following method. A screened interval volume is calculated using the interval from the top of the screen to the bottom of the well (TD). Once this volume is determined, it is used in the following format. When a well dewaters during development prior to evacuating the minimum five volumes, the number of complete volumes evacuated will be counted and subtracted from the five volumes. The number of volumes remaining will be calculated as screened interval and those volumes of DI water will be added to the well.

An effective method for adding DI water is to add one screened interval volume and begin pumping or bailing. If using the Grundfos Pump, trickle the remaining volumes in at the rate of pumping. This will keep water flowing across the entire screening interval to clean it. Keeping the water level at the top of the screened interval by trickling the remaining volumes into the well minimizes the hydrostatic head on the well. This reduces water loss to the formation. Some fluid loss can be expected if any portion of the sand pack is dry (irreducible water due to wetability of

the sand). If the well is being developed by bailing, add one screened interval and bail down. Continue this process until all the needed volumes have been added and evacuated. Any water loss experienced should be noted on the well development form.

3. When a monitoring well has an initial water column that covers only a portion of the screened interval but does not dewater prior to evacuating the five minimum volumes, no DI water will be added to the well.

4. When the initial water column is greater than the height of the screened interval but dewaters prior to completion of development, DI water will be added according to procedures described in 2 above.

5. All wells that measure technically dry initially will be bailed dry. This procedure will remove or partially remove well construction water and the first monthly WLM will more accurately reflect any groundwater recharge.

- Three consecutive well casing volume measurements of pH, temperature, and specific conductance are recorded (i.e., consecutive temperatures that are within 1°C, and pH readings that are within 0.2 units) and consecutive conductivity readings fall within 10 percent of each other. The calibration and use of these field instruments is described in SOP GW.5, Measurement of Groundwater Field Parameters.

- The goal of monitoring turbidity is to obtain water with formalin turbidity units (FTU) within 10 percent of each other for three consecutive readings. These readings should also be without a downward trend.

- If water is used during monitoring well drilling, the total fluid added will be calculated, and five times the fluid lost in the borehole during drilling will be recovered in addition to the five well casing volumes.

- The sediment in the well has been completely removed. One week after initial development, the well will be checked for the accumulation of additional sediment. Any additional sediment will be removed at the time of measurement.

- In low-yielding water-bearing formations, distilled water may be introduced into the well to facilitate development. A volume of water equal to the volume of distilled water added to the well must be recovered from the well within 8 hours or 3 times the amount prior to ceasing development activities (if possible).

5.2.2 Redevelopment of Pre-existing Wells

The pre-existing monitoring wells will be redeveloped in a manner similar to the well development for new wells. The equipment and procedures used for redevelopment will also be consistent with the equipment and procedures used for the development of new wells.

5.2.2.1 Redevelopment Criteria for Pre-existing Wells

The criteria to be followed for redevelopment of pre-existing wells will be:

- The removal of sediment inside the well.

- If the accumulated sediments cannot be removed, the goal of redevelopment will be to obtain stable field parameters (i.e., consecutive measurements of

temperatures that are within 1°C, pH readings within 0.2 units, and conductivity within 10 percent) after removing three well casing volumes.

- If the above mentioned results cannot be obtained, five well casing volumes will be removed and redevelopment stopped.

6.0 DOCUMENTATION

The following well development information will be recorded on the Well Development and Sampling Form (Form GW.2A) for newly installed wells.

- Well I.D. and location survey coordinates
- Date(s) of well installation
- Date(s) and time of well development
- Well designation
- Screened interval
- Well stick-up
- Static water level from measuring point
- Total depth from measuring point
- Volume of well casing volume

- Quantity of water used during drilling
- Depth from top of well casing to top of sediment inside well, before and after development
- Type of pump and/or bailer
- Field measurements of pH, specific conductance (SC), turbidity, DO, and temperature, taken in at least half-casing volumes
- Physical description of removed water throughout development (color and turbidity)
- Quantity of water removed and time for removal (incremental and total values)

The redevelopment of pre-existing wells will be documented on the Ground Water Re-Development Log Form (Form GW.2B).

WELL DEVELOPMENT AND SAMPLING FORM

Recorder's Name and Title _____

Well ID _____

Survey location coordinates: North _____ East _____

Date this report _____ Date well installation _____ Date well development _____

Well designation: _____

Ground elevation: Est: _____ Survey: _____

Screened interval: _____ Formation: _____

Measuring point (MP): Top of well casing/other: _____ Well stick up: ____

Water level (below MP): Start: _____ End: _____

Well depth (below MP): _____ Water elevation (BGS) _____

Method used to measure water level: _____ Estimated recharge rate: _____

Volume of saturated annulus (assume 30 percent porosity): _____

Volume Calculation: _____

Quantity of water used during drilling: _____

Depth of sediment (below MP): Before: _____ After: _____

Development equipment: _____

Sampling equipment: _____

pH meter No. _____ Calibration: _____

Specific conductance meter No.: _____ Calibration: _____

F.T.U. meter No.: _____ Calibration: _____

Time	Pumping Rate gpm	FTU	pH	Temp. °C	S.C. umhos/cm a: °C	Cum. Vol. of H_2O Removed		Physical Description of Water
						Gallons	Casing Vols.	

Comments: _____

_____

_____

_____

ROCKY FLATS PLANT
ENVIRONMENTAL RESTORATION
PROGRAM

ROCKY FLATS PLANT
GROUND WATER RE-DEVELOPMENT LOG

Project Name: Ground Water Re-Development Well I.D. _____

Project No.: 304902 . 1 2 • 0 3 • 0 1 Team Members: _____

QC Review By/Date: _____

Solinst: _____ (Serial Number) _____ (Calibration Date) Date: _____

PURGE METHOD - TYPE USED:

☐ PUMP ☐ PNEUMATIC ☐ PERISTALTIC ☐ INERTIA ☐ OTHER _____

☐ BAILER ☐ TEFLON ☐ STAINLESS ☐ OTHER _____

PURGING REQUIREMENTS & CALCULATIONS - Datum: Top of Well Casing (TOWC)

ID = Well Casing Inside Diameter (Inches) = _____

UV = Unit Casing Volume (gal/linear foot) = _____

WD = Depth to Water (feet) = _____

TD = Total Depth (feet) = Measured Total Depth (MTD)+Probe End _____

IC = Initial Water Column (feet) = TD - WD = _____ - _____ = _____

IV = Initial Water Volume (gallons) = UV x IC = _____ x _____ = _____

Checked by: _____

PURGED VOLUMES and RECHARGE

Volume Purged (GAL)	Temp (°C)	Conductance (mS/cm)	pH (SU)	DO (mg/L)	Nitrate (ppm)	Time (24-hour)	Turbidity (FTU)	Water Description (Color, Turbidity, Odor, Oil, etc.)

EQUIPMENT CALIBRATION

Equipment Type	Equipment ID #	Standard Used	Equipment Reading	Temp	Date	Time

FINAL WATER LEVEL MEASUREMENTS FROM MARK ON NORTH SIDE OF INNER CASING

Team Member	Reading	Total Depth	Probe End	Measured Total Depth	Avg. Meas. Total Depth
1	1				
2	2				
1	3				

Signature _____

Signature _____